Small Business Innovation Research/Small Business Tech Transfer

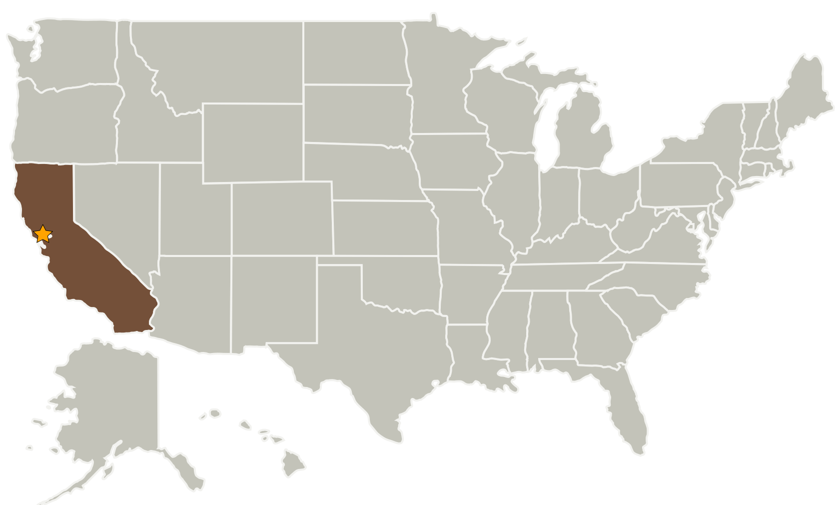
Analytical Methods for Verification and Validation of Adaptive Systems in Safety-Critical Aerospace Applications, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

A major challenge of the use of adaptive systems in safety-critical applications is the software life-cycle: requirement engineering through verification and validation. Adaptive systems incorporate learning to adapt the control system to the current operating conditions of the system, certifying their performance is a complex and tedious process. Ongoing effort in the development of tools for verification and validation of adaptive control systems, there is little research directed at the development of analytical methods. Learning rules for adaptive systems derivation using Lyapunov's second method, is based on the derivation of an energy-type function whose derivative must be negative to guarantee convergence therefore the asymptotic stability of the system. The first problem is that Lyapunov's second method provides a sufficient condition for stability thus the synthesis of an appropriate Lyapunov function for a particular application is a major challenge. The second problem in many applications, including the design of adaptive neural flight control systems, it is only possible to prove that the derivative of the Lyapunov function is non-positive, rather than being negative. For practical purpose, it is only possible to conclude that the control system errors are ultimately bounded, and it not possible to estimate the magnitude of these errors or the time it takes for these errors to converge to their steady-state limits. The objective of this research project is to develop analytical methods for the analysis of adaptive neural networks (ANN) based flight control systems including analytical estimates of the settling time and the steady-state magnitudes of the error dynamics. The magnitudes of the error bounds will be related to the performance handling qualities of the system and provide very important information about the performance of the closed-loop system.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Contek Research, Inc.	Supporting Organization	Industry	El Segundo, California

Primary U.S. Work Locations
California

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX10 Autonomous Systems
  └ TX10.4 Engineering and Integrity
    └ TX10.4.1 Verification and Validation of Autonomous Systems